

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (currently amended): A method for producing a spark plug including a center electrode, an insulator having an axial hole in an axial direction for holding the center electrode on a front end side of the axial hole, a metal shell for holding the insulator while surrounding the circumference of the insulator, and a ground electrode having one end portion joined to the metal shell, and the other end portion to which a columnar noble metal tip facing the center electrode is welded, wherein the noble metal content in a position far by about 0.05 mm inward a molten portion between the noble metal tip and the other end portion of the ground electrode from a boundary surface between the molten portion and a non-molten portion of the noble metal tip becomes 60 % or higher,

the method comprising the steps of:

resistance-welding a bottom surface of the noble metal tip on a side opposite to a counter surface of the noble metal tip to an inner surface of the other end portion of the ground electrode on a side opposite to the center electrode to thereby form a flange portion having a swollen outer diameter of the noble metal tip in a bottom portion of the noble metal tip; and

welding the noble metal tip to the ground electrode in such a manner that a laser beam is applied on the whole circumference of the flange portion of the noble metal tip obliquely at an angle and is directly applied to both the side surface of the noble metal tip and the surface of the electrode.

2. (currently amended): A method for producing a spark plug including a center electrode having a front end portion to which a columnar noble metal tip is welded, an insulator having an axial hole in an axial direction for holding the center electrode on a front end side of the axial hole, a metal shell for holding the insulator while surrounding the circumference of the insulator, and a ground electrode having one end portion joined to the metal shell, and the other end portion facing the center electrode, wherein the noble metal content in a position far by about 0.05 mm inward a molten portion between the front end portion of the center electrode and the noble metal tip from a boundary surface between the molten portion and a non-molten portion of the noble metal tip becomes 60 % or higher,

the method comprising the steps of:

resistance-welding a bottom surface of the noble metal tip on a side opposite to a counter surface of the noble metal tip facing the ground electrode to the front end portion of the center electrode to thereby form a flange portion having a swollen outer diameter of the noble metal tip in a bottom portion of the noble metal tip; and

welding the noble metal tip to the center electrode in such a manner that a laser beam is applied on the whole circumference of the flange portion of the noble metal tip obliquely at an angle and is directly applied to both the side surface of the noble metal tip and the surface of the electrode.

3. (previously presented): A method for producing a spark plug according to claim 1, wherein the noble metal tip is resistance-welded so that the sectional area of the flange portion in the axial direction of the noble metal tip is not smaller than 1.3 times as large as the area of the counter surface.

4. (currently amended): A method for producing a spark plug including a center electrode, an insulator having an axial hole in an axial direction for holding the center electrode on a front end side of the axial hole, a metal shell for holding the insulator while surrounding the circumference of the insulator, and a ground electrode having one end portion joined to the metal shell, and the other end portion to which a columnar noble metal tip facing the center electrode and a seat tip between the noble metal tip and the ground electrode are welded respectively, said seat tip having a thermal expansion coefficient between that of the noble metal tip and that of the ground electrode, wherein the noble metal content in a position far by about 0.05 mm inward a molten portion between the noble metal tip and the other end portion of the ground electrode from a boundary surface between the molten portion and a non-molten portion of the noble metal tip becomes 60 % or higher,

the method comprising the steps of:

resistance-welding a bottom surface of the noble metal tip on a side opposite to a counter surface of the noble metal tip to the seat tip joined to an inner surface of the other end portion of the ground electrode on a side opposite to the center electrode to thereby form a flange portion having a swollen outer diameter of the noble metal tip in a bottom portion of the noble metal tip; and

welding the noble metal tip to the ground electrode in such a manner that a laser beam is applied on the whole circumference of the flange portion of the noble metal tip obliquely at an angle and is directly applied to both the side surface of the noble metal tip and the surface of the electrode.

5. (currently amended): A method for producing a spark plug including a center electrode having a front end portion to which a columnar noble metal tip and a seat tip between the noble metal tip and the center electrode are welded, said seat tip having a thermal expansion coefficient between that of the noble metal tip and that of the center electrode, an insulator having an axial hole in an axial direction for holding the center electrode on a front end side of the axial hole, a metal shell for holding the insulator while surrounding the circumference of the insulator, and a ground electrode having one end portion joined to the metal shell, and the other end portion facing the center electrode, wherein the noble metal content in a position far by about 0.05 mm inward a molten portion between the front end portion of the center electrode and the noble metal tip from a boundary surface between the molten portion and a non-molten portion of the noble metal tip becomes 60 % or higher,

the method comprising the steps of:

resistance-welding a bottom surface of the noble metal tip on a side opposite to a counter surface of the noble metal tip facing the ground electrode to the seat tip joined to the front end portion of the center electrode to thereby form a flange portion having a swollen outer diameter of the noble metal tip in a bottom portion of the noble metal tip; and

welding the noble metal tip to the center electrode in such a manner that a laser beam is applied on the whole circumference of the flange portion of the noble metal tip obliquely at an angle and is directly applied to both the side surface of the noble metal tip and the surface of the electrode.

6. (currently amended): A method for producing a spark plug including a center electrode, an insulator having an axial hole in an axial direction for holding the center electrode on a front end side of the axial hole, a metal shell for holding the insulator while surrounding the circumference of the insulator, and a ground electrode having one end portion joined to the metal shell, and the other end portion to which a columnar noble metal tip facing the center electrode and a seat tip between the noble metal tip and the ground electrode are welded respectively, said seat tip having a thermal expansion coefficient between that of the noble metal tip and that of the ground electrode, wherein the noble metal content in a position far by about 0.05 mm inward a molten portion between the noble metal tip and the other end portion of the ground electrode from a boundary surface between the molten portion and a non-molten portion of the noble metal tip becomes 60 % or higher,

the method comprising the steps of:

resistance-welding the seat tip joined to a bottom surface of the noble metal tip on a side opposite to a counter surface of the noble metal tip to an inner surface of the other end portion of the ground electrode on a side opposite to the center electrode to thereby form a flange portion having a swollen outer diameter of the noble metal tip in a bottom portion of the noble metal tip; and

welding the noble metal tip to the ground electrode in such a manner that a laser beam is applied on the whole circumference of the flange portion of the noble metal tip obliquely at an angle and is directly applied to both the side surface of the noble metal tip and the surface of the electrode.

7. (currently amended): A method for producing a spark plug including a center electrode having a front end portion to which a columnar noble metal tip and a seat tip between the noble metal tip and the center electrode are welded, said seat tip having a thermal expansion coefficient between that of the noble metal tip and that of the center electrode, an insulator having an axial hole in an axial direction for holding the center electrode on a front end side of the axial hole, a metal shell for holding the insulator while surrounding the circumference of the insulator, and a ground electrode having one end portion joined to the metal shell, and the other end portion facing the center electrode, wherein the noble metal content in a position far by about 0.05 mm inward a molten portion between the front end portion of the center electrode and the noble metal tip from a boundary surface between the molten portion and a non-molten portion of the noble metal tip becomes 60 % or higher, the method comprising the steps of:

resistance-welding the seat tip joined to a bottom surface of the noble metal tip on a side opposite to a counter surface of the noble metal tip facing the ground electrode to the front end portion of the center electrode to thereby form a flange portion having a swollen outer diameter of the noble metal tip in a bottom portion of the noble metal tip; and

welding the noble metal tip to the center electrode in such a manner that a laser beam is applied on the whole circumference of the flange portion of the noble metal tip obliquely at an angle and is directly applied to both the side surface of the noble metal tip and the surface of the electrode.

8. (previously presented): A method for producing a spark plug according to claim 4, wherein the noble metal tip is resistance-welded in the resistance welding step so that the sectional area of the flange portion in the axial direction of the noble metal tip is not smaller than 1.2 times as large as the area of the counter surface.

9. (previously presented): A method for producing a spark plug according to claim 2, wherein the noble metal tip is resistance-welded so that the sectional area of the flange portion in the axial direction of the noble metal tip is not smaller than 1.3 times as large as the area of the counter surface.

10. (previously presented): A method for producing a spark plug according to claim 5, wherein the noble metal tip is resistance-welded in the resistance welding step so that the sectional area of the flange portion in the axial direction of the noble metal tip is not smaller than 1.2 times as large as the area of the counter surface.

11. (previously presented): A method for producing a spark plug according to claim 6, wherein the noble metal tip is resistance-welded in the resistance welding step so that the sectional area of the flange portion in the axial direction of the noble metal tip is not smaller than 1.2 times as large as the area of the counter surface.

12. (previously presented): A method for producing a spark plug according to claim 7, wherein the noble metal tip is resistance-welded in the resistance welding step so that the sectional area of the flange portion in the axial direction of the noble metal tip is not smaller than 1.2 times as large as the area of the counter surface.